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Educational Product	
Educators	Grades 3-5

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The NASA SCI Files™ The Case of the Radical Ride

**A Lesson Guide with Activities in
Mathematics, Science, and Technology**

Please Note: Our name has changed! The NASA "Why" Files™ is now the NASA SCIence Files™ and is also known as the NASA SCI Files™.

http://scifiles.larc.nasa.gov

The Case of the Radical Ride lesson guide is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site: **http://scifiles.larc.nasa.gov**

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NEC Foundation of America

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The NASA SCI Files™
The Case of the
Radical Ride

A Lesson Guide with Activities in Mathematics, Science, and Technology

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For additional information about the NASA SCI Files™, contact Shannon Ricles at (757) 864-5044 or **s.s.ricles@larc.nasa.gov**.

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Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kimlien.vu@swe.org**

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Program Overview

As Bianca and Kali arrive to meet the rest of the tree house detectives at the NASA auditorium for an awards ceremony, they learn that Dr. D, Jacob, and Katherine are having minor traffic problems. Convinced that they have plenty of time to get to the ceremony, and with not much else to do while they sit and wait, the detectives decide to work on their latest school project. The assignment is to come up with an idea for what transportation will look like in 100 years.

The detectives know that the best place to learn about the future is to visit the past, so they email Tony, who is visiting his aunt in Detroit, Michigan. They ask Tony if he can meet Barry Dressel at the Walter P. Chrysler Museum to learn about the history of transportation. Meanwhile, back in the van, Dr. D helps the tree house detectives understand that all future inventions and innovations must start with the engineering design process. The detectives get an email from two NASA SCI Files™ Kids' Club members, Wendy and Rosie, who are visiting Mr. Richard Storer at the Channel Tunnel in Folkestone, England. Mr. Storer helps the girls understand that once a problem is identified, a solution is sure to follow—eventually!

Tony's aunt also makes an appointment for him to visit Janet Goings at General Motors (GM) to learn about the importance of conducting research when using the engineering design process. Ms. Goings reveals some recent research as she shows Tony some really cool concept cars and explains how a fuel cell works. Back in the van, there seems to be no end to the traffic jam, so Dr. D makes good use of the time by explaining his research and model building experiences when he worked on his experimental hovercraft project. Wanting to know more about model building, the detectives email R.J. and ask him to visit Sam James at the Model Shop at NASA Langley Research Center. After learning how to make a model to scale, the detectives realize that testing is the next step in the engineering process. They join a videoconference in progress hosted by Mike Logan, NASA researcher, between students at Cooper Elementary School in Hampton, Virginia and King's Cross Education Action Zone in London, England. The students are competing in a mousetrap car contest and have just finished testing their model cars. They are analyzing their data so they can improve the distance the car travels. They realize that changes must be made!

Back in the car, Dr. D explains the iterative process and how engineers often have to test and redesign many times before achieving success. To learn more about the redesign process, R.J. sets off to visit Jeff Robinson at NASA Langley Research Center, who is working on the Hyper X, a new scramjet engine NASA is testing. Meanwhile, Bianca and Kali wait patiently for the tree house detectives to arrive, but they are beginning to get a little worried. Wishing that they had their own future form of transportation, they decide to learn more about maglev trains, and they contact a NASA SCI Files™ Kids' Club at Golightly Education Center in Detroit, Michigan. Mrs. Thomas's students are conducting experiments on magnetic force and have even built their own model maglev train.

Desperate to make the awards ceremony, the detectives decide it is time to get radical and come up with some really futuristic ideas for transportation that will help them avoid all future traffic problems. R.J. visits Andrew Hahn at NASA Langley Research Center, who explains all about a new concept for an airplane car. Mr. Hahn tells R.J. that the concept of the Personal Aerial Vehicle (PAV) is not that futuristic and that PAVs might be flying within the next decade. Fascinated by the possibility of having their very own personal airplane car and living in airport communities, the detectives are curious about what other radical things may happen in the future. They contact Terry Hertz at NASA Headquarters in Washington, DC to learn what cool things might be in the future for aeronautics. After dreaming about their next out-of-this-world tour to Mars, the detectives come back to Earth and are excited to learn that they are actually going to meet Frederick Gregory, the Deputy Administrator for NASA! Mr. Gregory encourages the detectives to stay in school and take lots of math, science, and technology courses to prepare for their future careers. He is also curious about where they do all their investigative work, so the tree house detectives invite Mr. Gregory to the tree house where no adult has been before!

National Science Standards (Grades K – 4)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
• Systems, orders, and organization	✖	✖	✖	✖
• Evidence, models, and explanations	✖	✖	✖	✖
• Change, constancy, and measurement	✖	✖	✖	✖
• Form and function	✖	✖	✖	✖
Science and Inquiry (A)				
• Abilities necessary to do scientific inquiry	✖	✖	✖	✖
• Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
• Properties of objects and materials		✖		✖
• Position and motion of objects	✖			✖
• Light, heat, electricity, and magnetism			✖	
Life Science (C)				
• Organisms and their environments	✖	✖	✖	✖
Earth and Space Science (D)				
• Properties of Earth materials	✖			
• Changes in Earth and sky	✖			
Science and Technology (E)				
• Abilities of technological design	✖	✖	✖	✖
• Understandings about science and technology	✖	✖	✖	✖
• Abilities to distinguish between natural objects and man-made objects	✖	✖	✖	✖
Science in Personal and Social Perspective (F)				
• Characteristics and changes in population	✖	✖	✖	✖
• Types of resources	✖	✖	✖	✖
• Changes in environment	✖	✖	✖	✖
• Science and technology in local challenges	✖	✖	✖	✖
History and Nature of Science (G)				
• Science as a human endeavor	✖	✖	✖	✖

National Science Standards (Grades 5 – 8)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Unifying Concepts and Processes				
• Systems, order, and organization	✖	✖	✖	✖
• Evidence, models, and explanations	✖	✖	✖	✖
• Change, constancy, and measurement	✖	✖	✖	✖
• Form and function	✖	✖	✖	✖
Science as Inquiry (A)				
• Abilities necessary to do scientific inquiry	✖	✖	✖	✖
• Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
• Motion and forces	✖	✖	✖	✖
• Transfer of energy	✖	✖	✖	✖
Earth and Space Science (D)				
• Structure of the Earth system	✖			
• Earth's history	✖			
• Earth in the solar system				✖
Science and Technology (E)				
• Abilities of technological design	✖	✖	✖	✖
• Understanding science and technology	✖	✖	✖	✖
Science in Personal and Social Perspectives (F)				
• Science and technology in society	✖	✖	✖	✖
History and Nature of Science (G)				
• Science as a human endeavor	✖	✖	✖	✖
• Nature of science	✖	✖	✖	✖
• History of science	✖	✖	✖	✖

National Mathematics Standards (Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Number and Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	✖	✖	✖	
Understand meanings of operations and how they relate to one another.	✖	✖	✖	
Compute fluently and make reasonable estimates.	✖	✖	✖	
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols.		✖		
Use mathematical models to represent and understand quantitative relationships.		✖		
Geometry				
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.		✖	✖	
Use visualization, spatial reasoning, and geometric modeling to solve problems.		✖		
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	✖	✖	✖	✖
Apply appropriate techniques, tools, and formulas to determine measurements.	✖	✖	✖	✖
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.		✖	✖	
Problem Solving				
Build new mathematical knowledge through problem solving.	✖	✖	✖	✖
Solve problems that arise in mathematics and in other contexts.	✖	✖	✖	✖
Apply and adapt a variety of appropriate strategies to solve problems.	✖	✖	✖	✖
Monitor and reflect on the process of mathematical problem solving.	✖	✖	✖	✖
Communication				
Organize and consolidate mathematical thinking through communication.		✖	✖	
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.		✖	✖	

National Educational Technology Standards
Performance Indicators for Technology-Literate Students (Grades 3–5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
Basic Operations and Concepts				
Use keyboards and other common input and output devices efficiently and effectively.	✖	✖	✖	✖
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Technology Productivity Tools				
Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.	✖	✖	✖	✖
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use telecommunication efficiently and effectively to access remote information, to communicate with others in support of direct and independent learning, and to pursue personal interests.	✖	✖	✖	✖
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖	✖	✖
Use technology resources for problem-solving, self-directed learning, and extended-learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem-solving, self-directed learning, and extended-learning activities.	✖	✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	✖	✖	✖	✖
Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.	✖	✖	✖	✖

International Technology Education Association Standards for Technological Literacy (Grades 3–5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
The Nature of Technology				
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	✖	✖	✖	✖
Standard 2: Students will develop an understanding of the core concepts of technology.	✖	✖	✖	✖
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	✖	✖	✖	✖
Technology and Society				
Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.			✖	
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	✖	✖	✖	✖
Standard 7: Students will develop an understanding of the influence of technology on history.	✖	✖	✖	✖
Design				
Standard 8: Students will develop an understanding of the attributes of design.	✖	✖	✖	✖
Standard 9: Students will develop an understanding of engineering design.	✖	✖	✖	✖
Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	✖	✖	✖	✖
Abilities for a Technological World				
Standard 11: Students will develop the abilities to apply the design process.	✖	✖	✖	✖
Standard 12: Students will develop abilities to use and maintain technological products and systems.	✖	✖	✖	✖
The Designed World				
Standard 18: Students will develop an understanding of and be able to select and use transportation technology.	✖	✖	✖	✖
Standard 19: Students will develop an understanding of and be able to select and use manufacturing technologies.	✖	✖	✖	✖
Standard 20: Students will develop an understanding of and be able to select and use construction technology.	✖			

National Geography Standards, (Grades 3 – 5)

Standard	Segment 1	Segment 2	Segment 3	Segment 4
The World in Spatial Terms				
How to use maps and other graphic representations, tools, and technologies to acquire process and report information from a spatial perspective	✖		✖	✖
How to use mental maps to organize information about people, places, and environments in a spatial context	✖		✖	✖
How to analyze the spatial organizations of people, places, and environments on Earth's surface	✖		✖	✖
Places and Regions				
How culture and experience influence people's perceptions of places and regions	✖	✖	✖	✖
Physical Systems				
The physical processes that shape the patterns of Earth's surface	✖			
Human Systems				
The characteristics, distribution, and migration of human populations on Earth's surface	✖	✖	✖	✖
The processes patterns, and functions of human settlement	✖	✖	✖	✖
Environment and Society				
How human actions modify the physical environment	✖			
How physical systems affect human systems	✖			
The changes that occur in the meaning, use, distribution, and importance of resources	✖			
The Uses of Geography				
How to apply geography to interpret the past	✖	✖	✖	✖
How to apply geography to interpret the present and plan for the future	✖	✖	✖	✖

The NASA SCI Files™
The Case of the
Radical Ride

Segment 1

On their way to an important awards ceremony, the tree house detectives and Dr. D run into traffic problems. After sitting in traffic, they conclude that there isn't anything they can do but wait, and they decide to begin investigating their next project. The project is to hypothesize what transportation will be like in 100 years. While wishing they had something futuristic to get them out of the traffic jam, the detectives decide that the best place to learn about the future is to look at the past. Tony sets off to learn about the history of transportation with Mr. Barry Dressel at the Walter P. Chrysler Museum in Detroit, Michigan. Meanwhile, back in the van, Dr. D helps the tree house detectives understand that all future inventions and innovations must start with the engineering design process. After learning that the design process begins with identifying a problem and then formulating solutions, they check in with two members of the NASA SCI Files™ Kids' Club, Wendy and Rosie, who are visiting Mr. Richard Storer, with Eurotunnel, at the Channel Tunnel in Folkestone, England.

Objectives

The student will

- create a time line of technology innovations in transportation.
- examine the engineering design process.
- demonstrate the brainstorming process.
- understand the concept of a natural land bridge and its effects on human and animal populations
- understand the challenges in constructing a tunnel.

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Vocabulary

Channel Tunnel—31 miles of railway tunnel with three interconnected tubes that run under the English Channel and connect the United Kingdom and France (continental Europe)

cycle—a series of regularly repeated events or operations that usually lead back to their starting point

design—to think up and draw the plans for something (e.g., design an airplane)

engineer—a person who is trained in or follows a branch of engineering as a profession

engineering—the science or profession of developing and using nature's power and resources in ways that are useful to people (e.g., designing and building roads, bridges, dams, or machines and creating new products)

iteration—a process in which a series of operations is repeated a number of times

problem—something to be worked out or solved; something that is hard to understand, deal with, or correct

solution—act or process of solving; an answer to a problem

time line—a schedule of events and procedures; a table listing important events for successive years within a certain historical period; a presentation of a chronological sequence of events enabling a viewer to understand temporal relationships at a glance

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 1 of *The Case of the Radical Ride*, read the program overview to the students. List and discuss questions and preconceptions that students may have about engineering and past, present, and future transportation.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the **Problem-Based Learning** tab.

a. **Problem Board**—Printable form to create student or class K-W-L chart

b. **Guiding Questions for Problem Solving**—Questions for students to use while conducting research

c. **Problem Log and Rubric**—Students' printable log with the stages of the problem-solving process

d. **Brainstorming Map**—Graphic representation of key concepts and their relationships

e. **The Scientific Method and Flowchart**—Chart that describes the scientific method process

3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. They can be printed ahead of time from the **Educators** area of the web site in the **Activities/Worksheet** section under **Worksheets** for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.
4. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. They can be printed by selecting Educators on the web site in the Activities/Worksheet section under Worksheets for the current episode.

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Radical Ride* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about transportation, engineering, and problem solving. Have the students conduct research on transportation and the engineering process to learn about transportation of the past and to begin brainstorming for ideas of what transportation might look like in a 100 years. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide them with the information needed.
4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools** section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
5. Choose activities from the Educator Guide and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the 2003–2004 Season and click on **Spacecraft Design Lab.**

a. To begin the PBL activity, read the scenario (Here's the Situation) to the students.

b. Read and discuss the various roles involved in the investigation.

c. Print the criteria for the investigation and distribute.

d. Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. The **Research Rack** is also located in the **Tree House**.

Careers

aeronautical engineer
inventor
mechanical engineer
museum curator

7. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
8. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.
9. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Resources (additional resources located on web site)

Books

Bender, Lionel: *Eyewitness: Invention*. DK Publishing, Inc., 2000, ISBN: 0789457687.

Brown, Don: *Alice Ramsey's Grand Adventure*. Houghton Mifflin Company, 2000, ISBN: 0618073167.

Diaz, James R.; and Carter, David A.: *Elements of Pop Up: A Pop Up Book for Aspiring Paper Engineers*. Simon and Schuster, 1999, ISBN: 0689822243.

Daimler-Chrysler: *The American Heritage of Daimler Chrysler*. DaimlerChrysler Corporation, 2002, ISBN: 090995202.

Heap, Christine: *The DK Big Book of Trains*. DK Publishing, Inc., 1998, ISBN: 0789434369.

Hewett, Joan: *Tunnels, Tracks, and Trains: Building a Subway*. Lodestar Books, 1995, ISBN: 0525674667.

Kassinger, Ruth: *Reinvent the Wheel: Make Classic Inventions, Discover Your Problem-Solving Genius, and Take the Inventors' Challenge*. Wiley, John and Sons, Inc., 2001, ISBN: 0471395390.

Kulling, Monica: *Eat My Dust! Henry Ford's First Race*. Bantam Doubleday Dell Books for Young Readers, 2004, ISBN: 0375815104.

Parker, Steven: *I Wonder Why Tunnels Are Round and Other Questions About Building*. Houghton Mifflin Company, 1995, ISBN: 1856975800.

Smith, Albert Gary; and Mason, Randy: *History of the American Automobile Coloring Book*. Dover Publications, Inc., 1990, ISBN: 0486263150.

Sullivan, Lee: *Tunnels Go Underground*. Lerner Publishing Group, 2000, ISBN: 1575054299.

Sutton, Richard: *Eyewitness: Car*. DK Publishing, 2000, ISBN: 0789458020.

Vanderwarker, Peter: *Big Dig: Reshaping an American City*. Little, Brown Children's Book, 2001, ISBN: 0316605980.

Resources (additional resources located on web site)

Video

Building Big—Tunnels. WGBH Boston Video, 2000, ASIN: B00004U2N4.

Web Sites

Walter P. Chrysler Museum
Take a virtual tour of the museum and see many of the cars created by Chrysler.
http://www.chryslerheritage.com/index.htm

Kids Design Network—Dupage Children's Museum
With Kids' Design Network, you'll investigate a challenge, dream up a design, and draw your plans on the computer; then, using the Internet, you can show your design to a real engineer, who'll help with your design so you can build it! Best of all, it's free!
http://www.dupagechildrensmuseum.org/kdn2/

The ASEE Engineering K–12 Center
On this great web site, you can find almost everything you need to learn about teaching engineering to K–12 students. The site has a wealth of great resources and links to wonderful engineering activities.
http://www.engineeringk12.org/

What You Need To Know About™—Automobile History
Visit this web site for everything from A–Z on the history of the automobile. See a time line, learn more about famous carmakers and inventors, and find out who invented the various components of a car, such as cruise control!
http://inventors.about.com/library/inventors/blcar.htm

How the English Channel Was Formed
Learn about the geology of England and France and how the English Channel was formed during the last ice age.
http://www.theotherside.co.uk/tm-heritage/background/channelform.htm

The Channel Tunnel
Learn the history of the Channel Tunnel and how it was built.
http://www.theotherside.co.uk/tmheritage/background/tunnel.htm

Eurotunnel
Home page of the company that runs high-speed car, coach, and freight shuttles linking the United Kingdom and France.
http://www3.eurotunnel.com/rcs/etun/pb_english/en_wp_home/en_pg_home_gateway_1/index.jsp

PBS—Building Big: Tunnels
This web site has all the tunnel basics. Students can learn about the tools and techniques used to build tunnels of the past and present, and they can learn more about various tunnels around the world. Read about the engineers who build tunnels and much more. Great teacher resources too, with educator guide!
http://www.pbs.org/wgbh/buildingbig/tunnel/index.html

Activities and Worksheets

In the Guide

Transportation on the Move
Create a time line depicting the history of transportation. 19

Let's Go Engineering
Use this simple checklist to help you get started in the engineering design process. 20

Designer's Log
This log will help you keep track of all your work as you design your next project. 21

What a Plan!
Use this great tool as you identify your problem and brainstorm for solutions. 23

A Stormy Brain
Try your hand at brainstorming and create a web of your ideas. 24

Tunneling Through
Learn about the challenges involved in tunnel building as you excavate and build a tunnel. 25

Answer Key
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On the Web

Bridging Across the Land
Learn about land bridges and how they affect human and animal populations.

Transportation on the Move

Purpose

To create a time line depicting the history of transportation

Note: Make your own paper tape by cutting and pasting together several strips of paper.

If using the Internet, try these suggested sites or conduct a web search of your own by using a search engine.

Fact Monster™ from Information Please™
http://www.factmonster.com/ipka/A0873323.html

Nationmaster
http://www.nationmaster.com/encyclopedia/Timeline-of-transportation-technology

What You Need To Know About Transportation
http://inventors.about.com/library/inventors/bl_history_of_transportation.htm

Materials

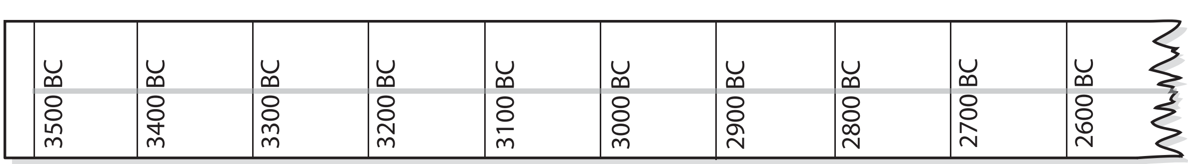
adding machine tape
pencils
markers
glue or tape
meter stick
reference books
Internet (optional)
science journal

Procedure

1. Research the history of transportation and determine the major milestones that you would like to include on your time line. Be sure to include the invention of the wheel.
2. In your science journal, list each milestone and the date in history that it occurred.
3. Draw, copy, or print small pictures for each milestone.
4. Determine the length of paper tape needed to span 6,000 years by deciding what increment will be used for each 100 years (i.e., centimeters, meters).
5. Use a meter stick to measure and cut the paper to the length you determined.
6. Divide the paper into equal 100-year sections using the increment you decided upon.
7. Use a meter stick to draw a line across the center of the paper to make one continuous line from beginning to end.
8. Write in the beginning year of each century. Mark the separation between BC and AD. Remember to count forward from the separation for AD and backward for BC.
9. Use glue or tape to attach the pictures above or below the year.
10. Display your time line in a hallway or on a wall in the classroom.

Extensions

1. Choose one invention or innovation and research its origins and history. Create a poster or report about your findings and present it to the class.
2. After watching the entire show, extend the time line 500 years into the future and add pictures of what you think future transportation inventions and innovations will look like.
3. Have each student or group of students research a 100- or 500-year time span and create a mini time line for just that segment of time. Connect all the time lines together to create a class time line that spans at least 6,000 years.



Let's Go Engineering

Engineering is fun and exciting, but did you know that most people don't have a clue what an engineer does? Almost everything in society is linked to engineering. If it weren't for engineers, we would not have cars, computers, televisions, and the many other conveniences that we take for granted each day. So just what is an engineer? An engineer is someone who is creative and thinks of new ways to solve problems by using math, science, and technology. Many people think that an engineer is a scientist, but even though they may use science, engineers are not usually scientists. Theodore Von Karman, an aerospace engineer, put it nicely when he said, "Scientists discover the world that exists; engineers create the world that never was." There are many different types of engineers, such as electrical, mechanical, civil, chemical, aerospace, biomedical, agricultural, computer, and many more. There is an engineer for almost every area that might be interesting to you!

When engineers have ideas, they usually follow a few simple steps to help them as they search for the solution. Use the checklist below to help you as you design your solution to the challenge.

- ❑ Keep a design log. Engineers keep a log to record their work and ideas.
- ❑ Use your imagination. Think wild and crazy thoughts. Remember that no idea is too silly. Everyone laughed at the Wright brothers and said that man would never fly. Good thing they didn't get discouraged!
- ❑ Plan and design your idea. Careful design is important. Now is the time to brainstorm for ideas and evaluate them.
- ❑ Research. Conduct research to verify that your design is based on sound science and math principles.
- ❑ Draw your design. Make a detailed drawing of your idea so others will understand how your design works.
- ❑ Make a model of your design.
- ❑ Test your design. Test your model to see if it works as planned.
- ❑ Evaluate your test results. Use data collected from testing to determine whether your design performs as it was meant to perform.
- ❑ Redesign. If your design did not work as planned, do more research, redesign it, and test it again. This procedure is called an iterative process.
- ❑ Patent your design. Engineers often have unique designs that others might want, so they apply for a patent from the U.S. Patent Office to protect their ideas from being claimed by others.

Designer's Log

Keeping a log is very important. It can prove that you had an idea first. It can also help you plan your design and help you explain your design to others when you are finished. Follow the suggestions below to help you keep a detailed and accurate log and become a true engineer!

- Every time you work on your design, take notes and record when and where you were when you had the thought. Also record the results of the work. Date and initial your notes.
- Describe all your ideas, plans, designs, models, tests, and results in great detail. Details are very important because they help others understand your design.
- When possible, make a drawing of your ideas and your design. Be sure to label all the parts clearly and correctly so that others will be able to understand how your design works.
- If you need to buy items to build your model, describe the materials and keep a list of the costs.
- Photos can be included in your log because they are excellent proof of your design.
- Be sure to have an adult sign your log. He/she will be a witness to prove that the idea and work are your own.

Sample Log

Name: Wilbur Wright **Date:** February 12, 1902

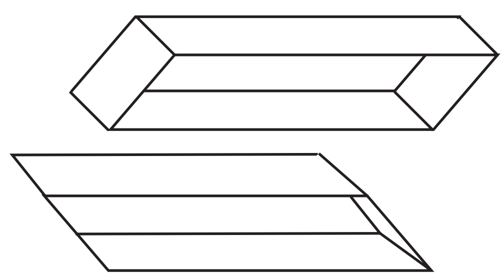
Witness: Orville Wright **Time:** 10:02 AM

Location: Wright Bicycle Shop, Dayton, OH

Details

Discussed with Orville the problem of control. After observing the bicycle tube box, an idea came to me - Wing warping.

Drawings or photos



Designer's Log

Name: ______________________ **Date:** ______________________

Witness: ______________________ **Time:** ______________________

Location: ______________________

Details	Drawings or photos

What a Plan!

Use this worksheet to help plan your design, but don't forget to record your plans in your designer's log!

Challenge ______________________________

Solutions

List the top 5 solutions from your brainstorming:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Criteria

Develop a list of criteria to aid in evaluating your ideas.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Questions

1. Ask yourself what makes a good design. ______________________________
____
2. Is my design easy to construct?______________________________
3. Do I have the materials needed for my design?______________________________
4. Does my design meet the criteria for the challenge? ______________________________

Identify the Best Solution

After evaluating each solution or design, choose the best one to solve the problem.

Verification

Write a brief summary of why this design is best and how it will meet the criteria for the challenge or problem.

____
____
____
____
____
____

A Stormy Brain

Materials

pencils
markers
large sheet of paper

Purpose

To learn how to link ideas and questions together to form a relationship

Background

Brainstorming is fun and can be helpful when trying to solve problems. It is a process of spontaneously thinking and sharing as many ideas as possible about a topic without being judgmental. Brainstorming is an important part of the problem-solving process, and there are a few suggested guidelines to follow when you brainstorm. Remember that everyone is welcome and that all ideas are valuable. Don't be critical and focus on sharing lots of ideas because the more the better. Also welcome hitchhiking or piggybacking where one idea will spark another similar idea or enhance one already given. The sky is the limit, so even outrageous and humorous ideas are accepted.

To learn more about brainstorming, visit our web site for these tools:
Brainstorming Rules
http://scifiles.larc.nasa.gov/educators/tools/pbl/brainstorming_rules.html

Brainstorming Map
http://scifiles.larc.nasa.gov/educators/tools/pbl/brainstorming_map.html

Procedure

1. Read the challenges below and, as a group, choose one to work on.
2. Brainstorm for ideas about how to solve the challenge. Be sure to record all ideas.
3. Create a brainstorm map or web of your ideas. It might help to use different colored markers for the various solutions placed in the web.
4. Discuss your web and all the possible solutions.
5. Reach a consensus for the one solution that best solves your challenge.
6. Write a short description of your solution and defend why it is the best one.
7. Present your solution to your class.

Challenges

1. You just finished your soccer game and are ready to head home when you notice that your bike has a flat tire. You look around to see if you can catch a ride with one of your friends, but they have already left. You have 50 cents in your pocket, but there aren't any pay phones close by. The dark clouds in the sky indicate an approaching thunderstorm. You need to do something quickly. What should you do?
2. When astronauts go to Mars, they will be gone for about 2 years. A lot of their food will need to be preserved. Preserved food is often high in sodium (salt), but sodium counteracts the calcium your body needs to maintain strong and healthy bones. When working in a microgravity environment, an astronaut's muscles can deteriorate (atrophy) over time. Also, in a microgravity environment, the human skeleton supports less weight and will begin to decrease in size (lose bone mass). NASA needs your help to solve this problem: What should NASA scientists and researchers recommend to overcome the problems of muscle and bone loss in a microgravity environment?

Extension

1. Conduct a survey of parents, friends, and other family members to see if they think your solution is the best answer to the challenge.

Tunneling Through

Purpose

To understand the challenges involved in constructing a tunnel

Teacher Note

Have students bring in various items for constructing their tunnels. These items might include spoons (for digging), popsicle sticks, paper tubes, tape, glue, aluminum foil, wax paper, tissue boxes, and so on.

If you have Internet access, check out PBS's web site, **Building Big: Tunnels—Tools and Techniques**, to learn more about tunnels and the tools used to build them.
http://www.pbs.org/wgbh/buildingbig/tunnel/challenge/tools/index.html

Have the students try the activity from PBS's web site, "Meeting in the Middle," prior to digging their tunnel. With this activity, discover what it takes to align a tunnel that is being constructed from two different directions and have both sections meet in the middle.
http://www.pbs.org/wgbh/buildingbig/educator/act_middle_ho.html

Materials

copy-paper box
large, plastic bag
soil and sand to fill box
large, shallow pan
water
metric ruler
marker
tunnel supplies

Procedure

1. Label one end of the copy-paper box "North" and one end "South."
2. Line the copy-paper box with a large, plastic bag.
3. Fill the box 3/4 full with a mixture of soil and sand.
4. Add water to the mixture until it is slightly wet. See diagram 1.
5. Scoop out some of the soil mixture and place the shallow pan in the soil. Arrange soil mixture so that it meets the edges of the pan. Fill the pan with water, forming a small "lake." See diagram 2.
6. Let the box sit overnight to dry and harden the soil mixture.
7. To begin your tunnel, you will need two crews. One crew will begin to dig from the North end and the other will dig from the South end.
8. Hold a planning meeting with both crews and determine the construction constraints of your tunnel.
9. Identify the diameter and depth of the tunnel and anything else that might be important.

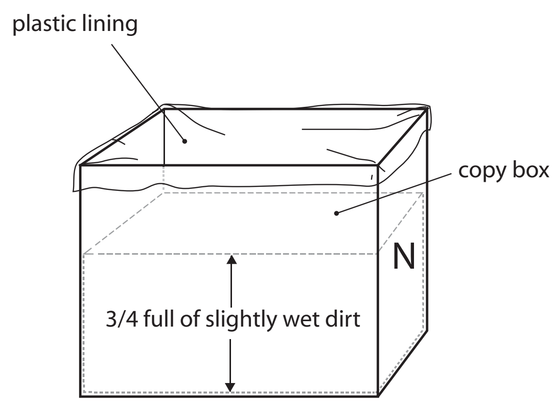


Diagram 1

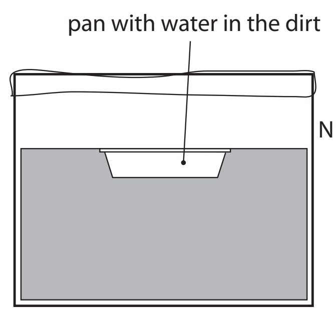


Diagram 2

Tunneling Through

10. The tunnel must be at least 15 cm below the lake bed.
11. Remember that both tunnels must meet in the middle at exactly the same spot. Discuss and brainstorm for ideas on how you will successfully build each tunnel so that they will line up properly and fit together exactly when the two tunnel halves meet in the middle.
12. Draw a design plan of your tunnel.
13. When you're ready, begin construction on your tunnel and continue until one continuous tunnel is formed. See diagram 3.
14. If it's available, add train track and send a train through your tunnel for its inaugural tunnel crossing.

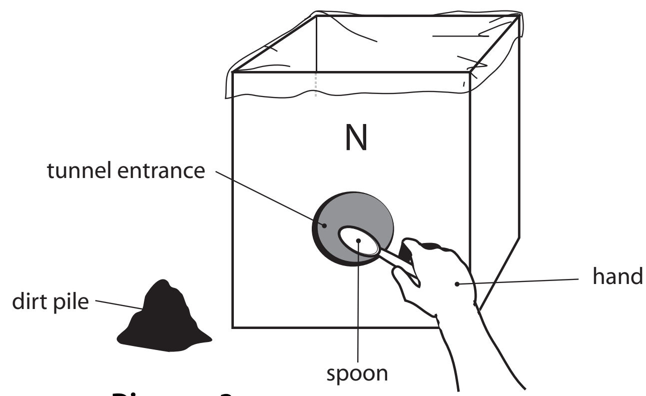


Diagram 3

Conclusions

1. What difficulties did you encounter as you dug your tunnel from opposite ends of the lake?
2. What would you do differently next time?
3. What are some benefits of digging two separate tunnels?
4. Which crew dug the longest distance and why?

Extensions

1. For a math lesson on budgeting, give each team a budget for building a tunnel and a set of specific equipment for the project, attaching a cost to each item (i.e., spoon: $50,000; paper tube: $500,000). If they break the equipment or need additional supplies, the team is charged accordingly. Set a project deadline and charge by the minute or hour if they don't meet the deadline. The teams must keep track of their budget and expenses to show a profit or a loss. The team that comes in closest to budget wins.
2. Build two tunnels, one for northbound traffic and one for southbound traffic. Justify the need for two tunnels and the benefits gained.
3. Add pebbles, large rocks, and other items to the soil mixture to create obstacles for the team to overcome while digging the tunnel

Answer Key

Tunneling Through

1. Answers will vary, but might include that it was difficult to keep the tunnel level, going straight, and many other obstacles that could have occurred.
2. Answers will vary.
3. Answers will vary, but some benefits are that two separate tunnels would allow traffic to go in only one direction in each tunnel, which might help stem accidents. Two tunnels would also be beneficial because if a disaster occurred in one tunnel, the other tunnel could be used. Also, in case of an emergency evacuation for such things as hurricanes, both tunnels could be opened for traffic to go in the same direction.
4. Answers will vary.